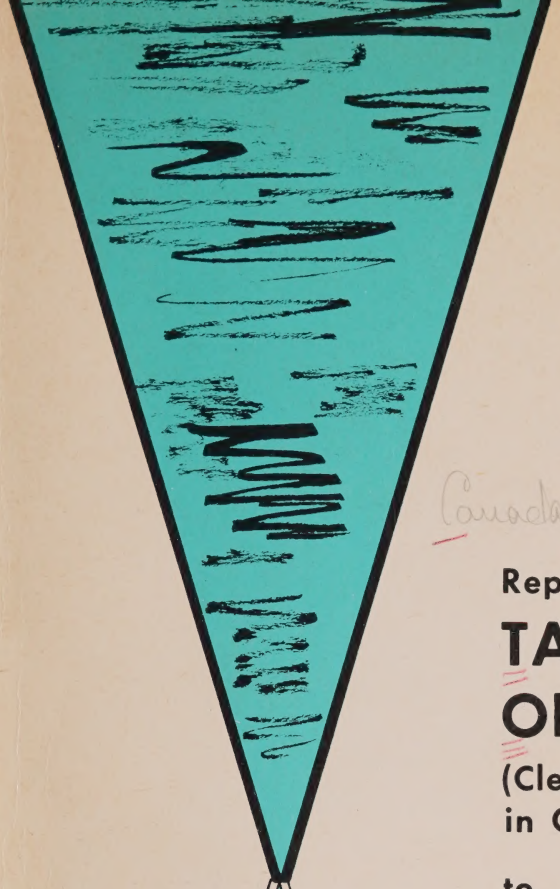

Report of the

TASK FORCE - OPERATION OIL

(Clean-up of the Arrow oil spill in Chedabucto Bay)

to

The Minister of Transport

VOLUME I—3

ISSUED BY THE MINISTRY OF TRANSPORT

Report of the

TASK FORCE - OPERATION OIL

(Clean-up of the Arrow oil spill in Chedabucto Bay)

to

The Minister of Transport

Cat. No.: T22-2470/1

OPERATION OIL

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Ottawa, Canada

1 September, 1970

The Hon. Don Jamieson, P.C., M.P.,
Minister of Transport,
Ottawa, Canada.

Dear Mr. Minister,

This report contains the main features of our experience in dealing with the major oil spill in a cold environment resulting from the wreck of the Liberian tanker *Arrow* on Cerberus Rock in Chedabucto Bay, Nova Scotia, on the 4th of February, 1970. It records our experiences to date and our conclusions and recommendations which we hope will be helpful to you and to those who might have the occasion to be assigned similar chores in the future.

We note with pleasure that some of our recommendations are already subsumed by the legislation which has been under preparation for several months and we understand will be introduced at the forthcoming session of Parliament. We also understand that some of our other recommendations are anticipated by the underlying principles of this legislation.

The recommendations that we feel are important and indeed urgent for your consideration are summarized in the following pages, while the summary of our operations and the detailed justification for our recommendations are found elsewhere in this report. There is a wealth of detail, helpful experience and conclusions contained in Volumes II and III of this report which were written by those who had expertise and experience in the areas dealt with. They are presented largely without our editing and therefore, while we do not agree with all their detailed conclusions and recommendations, there will be minor internal conflicts. Through their helpful participation in the dirty job of picking up the garbage in Chedabucto Bay, we think they have earned the right to be heard and have their conclusions given serious consideration by the experts who will follow.

While this report is complete up to the present, there will be a residual pump-out of the stern section of the wreck in the early part of September which will add significantly to our technology in this area. The Lennox Passage and Canso Tickle dams remain to be opened and beaches are still being cleaned. There is also much important ongoing research. We have in mind a critical analysis of the Bay next spring so that we can acquire positive knowledge on the extent of the natural cleaning of the shoreline by the winter storms. We plan to present to you a supplementary report on the pump-out and our final experiences. We urge the ongoing support of the research so that its fruits may appear in the world's scientific literature for months and indeed years to come, so that those who next have the job of tackling a spill of Bunker C in cold water will derive full advantage and assistance from our collective absence of helpful information from the world's storehouse of knowledge.

We have received, in the course of our operations, much undeserved credit for some of the things that were done for us by the magnificent staff which we were able to assemble and who worked with such dedication. We would like to underscore indelibly to you and to all those who may read this report that this is not a success story. It is the story of a pollution Dunkirk. We hope that our efforts have mitigated to some degree the damage and distress caused to the good people who live and work around Chedabucto Bay and those who earn their living fishing in these waters. We would like to stress that we have recovered and put into shore tanks only 1.3 million gallons of the *Arrow's* cargo and we have placed in carefully approved dumpsites perhaps another half million gallons. The rest is on the shores of Chedabucto Bay, polluting the Atlantic Ocean or being eaten by

the microbes which live naturally in the water column. We have no idea how fast these microbes will work. We have only estimates of the rate at which nature will do the final cleaning. Our efforts in recovering the oil from the water have led to the removal of most of that which was still afloat.

We have cleaned to the best of our ability 58 wharves and jetties in the area and the tourist and community beaches. Of the 375 miles of beautiful shoreline in Chedabucto Bay, 190 miles was contaminated to a greater or lesser extent by the *Arrow's* cargo and our efforts on the beaches cleaned only 30 miles. The remaining shoreline is virtually uncleanable unless one resorts to chemical methods which themselves would place the marine fauna and flora of the Bay in jeopardy to an extent unacceptable to your Task Force.

While we are nearing the end of our assignment and our personal contributions will naturally be quickly forgotten, we hope that the misery of the people in Chedabucto Bay will not. We leave for debate in the scientific journals the ongoing extent of the ecological damage to the intertidal zone and the more tenuous and sophisticated considerations of the ultimate disposition of the oil that enters the water column.

With the ongoing international debate about offshore limits and the national concern and action on pollution hazards, we wish to underscore the evidence from the *Arrow* disaster. Oil from the tanker *Arrow* moved from Chedabucto Bay as a result of mechanisms not yet clearly understood and fouled the beaches of Sable Island from one end to the other, even though Sable Island is over 100 miles from Chedabucto Bay. In the process an additional 4,800 birds lost their lives. There is no reason to expect that oil from an offshore catastrophe would not travel a similar distance towards the shore and therefore foul beaches well beyond the 100-mile limit. Any nation which elects to complain about the 100-mile limit set by Canada for Arctic pollution is not now facing the facts, unless their position is that tankers or oil wells in what the world now calls "international waters" can foul the beaches of a nation with impunity, a position which we would argue is both socially and ecologically unacceptable.

But we would like to recall the words of Churchill after the real Dunkirk:

> "We must be very careful not to assign to this deliverance the attributes of a victory. Wars are not won by evacuations. But there was a victory inside this deliverance which should be noted."

These words are adequate for our operation and will be applicable to any similar actions that follow to deal with oil spills after they occur. Each spill will have its own characteristics, its own family of problems, but the only real solution is to do everything possible to prevent the occurrence.

In this connection we are appalled by the callousness and sloppiness that we find in the operation of the world's tanker fleets, particularly those which sail under flags of convenience. While in 1959 the world's total loss of tankers was 350,000 tons, the Petroleum Press Service in April 1970 records tanker losses of almost 600,000 tons during the second half of 1969. This is the equivalent of 33 ships the size of the *Arrow* in 26 weeks. The sailing of ships is inherently easier and should be safer than the operation of commercial aircraft. They are substantially slower and it is a two-dimensional rather than a three-dimensional navigation problem. It is our judgment that until the nations of the world get together and sign a shipping convention, embodying the principles that have existed since the end of World War II in the civil aviation convention, of positive control and discipline, of proper standards of adequacy of equipment, crew competence, terminal and other navigational aids and equipment, the world is paying lip service to a problem of growing dimensions. We see no reason why the countries which have signed and lived up to the civil aviation convention for the past many years should find it impossible to adopt a similar convention to bring order out of chaos in marine navigation and particularly in tanker operation. This problem will continue to grow in seriousness because in the same issue of Petroleum Press Service, under the heading "Record Tonnage on Order", the following appears:

"Of the total of 403 tankers on order, 298 vessels accounting for 41 million dwt are scheduled for delivery during 1970 and 1971, although Jacobs estimates that actual deliveries each year may be nearer 18 to 19 million tons. Ownership of these new ships is divided roughly 2 to 1 between independent owners and oil companies, with at least one-third of the total expected to be registered under the Liberian flag."

The following quote from the same journal we think completes this picture:

"The *Torrey Canyon* disaster alerted the world to the possibility of giant tankers breaking up and discharging vast quantities of oil, but lesser incidents occur from time to time —– recently a tanker ran aground off Nova Scotia causing coastal damage." (our *Arrow*)

"Several recent accidents involving very large tankers have not resulted in extensive pollution because the vessels were in ballast. This was the case in two accidents, one off Marseilles and one off Singapore, in which 100,000-ton tankers were lost. Similarly, a 200,000-ton tanker which sank off Dakar, and two of similar size that caught fire off Africa following explosions, were all empty. The latter accidents have not been fully accounted for and anxiety remains."

When one considers that an order has already been placed for one ship of 370,000 tons and a provisional order has been placed for one of 400,000 tons we suggest that the world should reinforce this anxiety.

To put all of this in perspective, the Liberian tanker *Arrow* was 18,000 deadweight tons.

While we realize that the forging of an acceptable, tough, international convention which will have the effect of reducing these idiotic and unnecessary tanker losses to the same level as that achieved by international aviation will be a long and at times frustrating exercise, we suggest that it can now be hammered out on the anvil of experience. In the meantime we suggest that Canada protect itself, because under the present sloppy conditions and with the increasing movement of petroleum products in Canadian waters, a second major spill is highly probable.

We suggest that much can be done to bring a positive type of control on ships moving in Canadian waters. Electronic equipment to place all shipping under positive control exists and should be installed. Compulsory pilotage in Canadian waters and regular inspection of all ships and their equipment are straightforward steps which would help. An insistence on proper standards of competence of crew on all ships entering Canadian waters would be more difficult to enforce but is essential in the long run.

For those who intentionally disregard both the law and the rudiments of safe navigation, the punishment must fit the crime. The paltry fines now levelled against those who are convicted of oil pollution have no detectable deterrent effect.

The substantial number of minor harbour spills are the result of callous disregard or stupid inattention. They can and should be virtually eliminated.

We are well aware of the fact that no form of transportation can be 100 per cent safe but from the record available to us the standard of operation of the world's tanker fleets, particularly those under flags of convenience, is so appalling and so far from the kind of safety which science, enigneering and technology can bring to those who care, that the people of the world should demand immediate action.

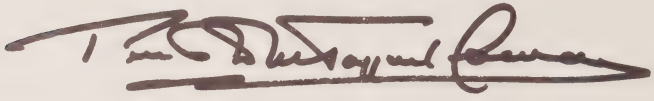
We have made a specific recommendation that a small but hard-hitting cell of experts be established within the Ministry of Transport responsible for drawing up and implementing contingency plans, steering research, and co-ordinating intergovernmental and international plans and agreements. We strongly urge that this step be taken at once. The nation can ill afford any delays in consolidating its ability to prevent or deal with any future disasters. We would also hope that the terms of reference and direction they receive will be as simple and flexible as those given to us.

We have also made recommendations with respect to the roles of other departments on the basis of our experience and we recognize that they will wish to examine these in the light of their own plans and experience.

Our final plea is for the support of ongoing research into the problems presented by spills of petroleum products. Our job would have been virtually impossible had it not been for the massive support we received from the scientific community in Canada. Because of the pressure of time much of the information they provided to us was of a preliminary nature or an educated opinion by the scientists at the forefront of knowledge in that area. We draw this operation to a close with more questions than answers, with partial answers that should urgently be pressed to finality, and a host of physical, chemical and biological questions which need answers. It is important that those who have the ongoing responsibility assess the work now in progress throughout the world in these areas, but it is obvious to us that unless Canada carries out the work specific to cold and Arctic enviornments no one else is likely to do it for us. We suggest that we have within the Canadian scientific community the people and the enthusiasm, and ongoing federal financial support is the remaining link needed to forge this vital chain of human understanding.

While no one of us has enjoyed dealing with the mess in Chedabucto Bay, we have enjoyed working for you and thank you for your continuing support as we struggled through our successes and our mistakes.

Yours sincerely,



P.D. McTaggart-Cowan

H. Sheffer

M.A. Martin

PART 2 - SUMMARY OF RECOMMENDATIONS

Our recommendations appear in various parts of this report as they arise naturally in the course of our presentation. For convenience they are collected here and rearranged under general headings with a cross reference to the page in the text where they appear.

International Action

We recommend that

consistent with the initiatives taken by the Government with respect to Arctic pollution and at the IMCO special conference on pollution in 1969, Canada take a parallel initiative to convene a conference of all those concerned to write a new international convention for the operation and control of shipping throughout the world and that this convention be patterned on the principles of the Convention on International Civil Aviation.

(see page 28)

the convention should ban all deliberate pumping of oil, oily waste or tank cleanings, or bilge cleanings into the oceans or any other body of navigable waters

(see page 28)

Canada should take the initiative with the appropriate international bodies to seek agreement on a series of definitions and descriptions that will permit the reporting of spills in an orderly and understandable manner.

(see page 27)

National Action

We recommend that

extensive pollution control zones be established to cover the rest of the coast of Canada consistent with the position taken by the Government in the Arctic

(see page 30)

the law should make it clear that those who pollute pay the complete cost of clean-up, including the cost of any Canadian federal or provincial personnel used in the clean-up, that the ship concerned be impounded until this has been accomplished or assured and that the legal penalties be in addition to this liability for the complete cost of cleaning up the pollution.

(see page 30)

We recommend that

1) *with respect to tanker operations, in order to enter Canadian waters, they provide evidence that they are fitted with adequate and serviceable navigation equipment*

2) *Canadian pilots be required on all vessels entering Canadian waters unless the ship and its captain have been given special clearance by the federal authority*

3) *standards of competence of crews of ships entering Canadian waters should conform with our national standards*

4) *the same principles as in 2) and 3) above should apply to Canadian ships in Canadian waters*

5) *there should be a compulsory filing of samples of all petroleum products loaded on ships*

and a requirement that any spillage of petroleum products, regardless of whether they originate from a shore tank or a ship, be immediately reported and sampled

6) *the federal government establish one or more central laboratories capable of "finger-printing" petroleum products in a manner acceptable to the courts*

(see page 29)

7) *until a better scheme is developed, the tankers and barges used in the petroleum trade be fitted with the Madsen valves.*

(see page 37)

We recommend that

1) *all bulk storage tanks holding petroleum products or other hazardous substances be protected by dykes capable of containing the entire contents of the tank*

2) *pipelines running along water courses be similarly dyked.*

(see page 29)

Organization and Preparedness

1. GOVERNMENTS

We recommend that

1) *the federal government should have the operational responsibility and authority for all major spills at sea and should reach agreement urgently with the provincial governments concerning the responsibility for all other major spills*

2) *with respect to moderate spills within provincial jurisdiction, agreements be reached with each province*

3) *with regard to minor spills agreements be reached between the provincial government and municipalities, with the provincial government having someone on site to take over in case the municipality is unable to cope.*

(see page 31)

We recommend that

the Minister of Transport have the responsibility for dealing with pollution arising from oil spilled in water when the extent and nature of the spill makes it a federal responsibility.

(see page 30)

2. MINISTRY OF TRANSPORT

We recommend that

this responsibility of the Minister of Transport be focused in a small team at the headquarters level and comprising a minimum of one physical scientist, one biological scientist and one operations expert, with the physical scientist being the leader

(see page 30)

very careful attention be given to the community relations aspects of contingency and operation plans and that those information officers who are capable of effectively operating in a community relations setting be identified, involved with the headquarters team in the planning, and be immediately available when operations are mounted to deal with a pollution incident

(see page 39)

stockpiles of material be located at strategic ports. These would include peat moss or other absorbents, booms and boom components, and a variety of equipment not readily available, which will vary with each location

(see page 37)

at least one slick-licker be placed at each major port on the Canadian coast and that at least two others be held in a central contingency packet

(see page 37)

the Canadian Coast Guard have primary responsibility for the recovery of oil floating on the water, which will include slick-lickers, containment booming and all other ramifications

(see page 37)

the Canadian Coast Guard be responsible for steam cleaning operations.

(see page 38)

3. DEPARTMENT OF NATIONAL DEFENCE

We recommend that

HMCS Cape Scott and Cape Breton be maintained operationally ready to fulfil primary roles in the national contingency plan

(see page 33)

the Department of National Defence take on the responsibility of developing an operational communications plan so that in an emergency all segments of the federal government in the field can communicate with one another.

(see page 33)

4. INDUSTRY

We recommend that

the oil industry reach agreement among themselves to provide on immediate call from a Federal Government Task Force suitable oil recovery vessels

(see page 36)

industry be heavily involved in research, development and production of equipment and material needed for the contingency packages on the one hand and the actual clean-up operations on the other, as well as devices to assist in the prevention of pollution incidents.

(see page 35)

5. DEPARTMENT OF PUBLIC WORKS

We recommend that

the Department of Public Works provide engineers to supervise the beach cleaning operation

(see page 38)

6. DEPARTMENT OF ENERGY, MINES AND RESOURCES
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT
DEPARTMENT OF FISHERIES AND FORESTRY
DEPARTMENT OF NATIONAL HEALTH AND WELFARE
NATIONAL RESEARCH COUNCIL
AND SUPPORT OF RESEARCH

We recommend that

the scientific advice required by the headquarters team in the Ministry of Transport be provided by a group actively concerned with a portion of the research themselves. This advice will include assessment of research done in other countries, assessment of proposals for research to be carried out in Canada, and advice on grants to universities and industry to involve them in research, development and innovation in this area of pollution and its

prevention. We feel that at the present time the best group to perform this function is the group that came together in Halifax on an ad hoc basis for Operation Oil headed by Dr. W.L. Ford, Director of the Atlantic Oceanographic Laboratory.

(see page 31)

money for the support of relevant research at universities and in industry should be made available to the Ministry of Transport and disbursed on the recommendation of the headquarters team with the assistance of thier scientific advisers

(see page 31)

the initial funds to support the Canadian research effort on oil pollution problems in universities and industrial laboratories be $250,000 per annum

(see page 40)

the National Science Library be the central repository for literature dealing with oil pollution and that there should be no proliferation of library holdings in the various federal government departments.

(see page 39)

PART 3 - SUMMARY OF OPERATIONS

Introduction

At 0930 hours, local time on 4 February 1970 the oil tanker *Arrow* struck Cerberus Rock in Chedabucto Bay (Figure 1). The 18,000-ton (deadweight) Liberian ship owned by Sunstone Marine S.A. Panama was carrying 16,000 tons (108,000 bbls. or 3.8 million Imperial gallons) of Bunker C fuel oil for Imperial Oil Limited from Venezuela to a plant in the Strait of Canso.

During attempts at salvage, the ship broke in two on 12 February with the bow section fast on the rock and the stern section on the gravel bottom at a depth of about 95 feet some 700 yards to the north. In addition to the salvage attempts, burning and dispersing experiments were conducted under the auspices of Imperial Oil and certain areas were protected by booms prior to the formation of the Task Force on 20 February. Since the details of events transpiring between 4 February and 20 February are not known to the Task Force, they are not included in this report but they will be produced in evidence during the hearings to be conducted by Commissioner Justice G.L.S. Hart in September.

On 20 February the Minister of Transport, the Hon. Don Jamieson, formed the three-man Task Force consisting of:

Head	- Dr. P.D. McTaggart-Cowan, Executive Director, Science Council of Canada
Deputy Head	- Dr. H. Sheffer, Vice-Chairman, Defence Research Board and Captain (N) M.A. Martin, Deputy Chief of Staff (Combat Readiness), Maritime Command Headquarters, Canadian Armed Forces,

with the following simple Terms of Reference:

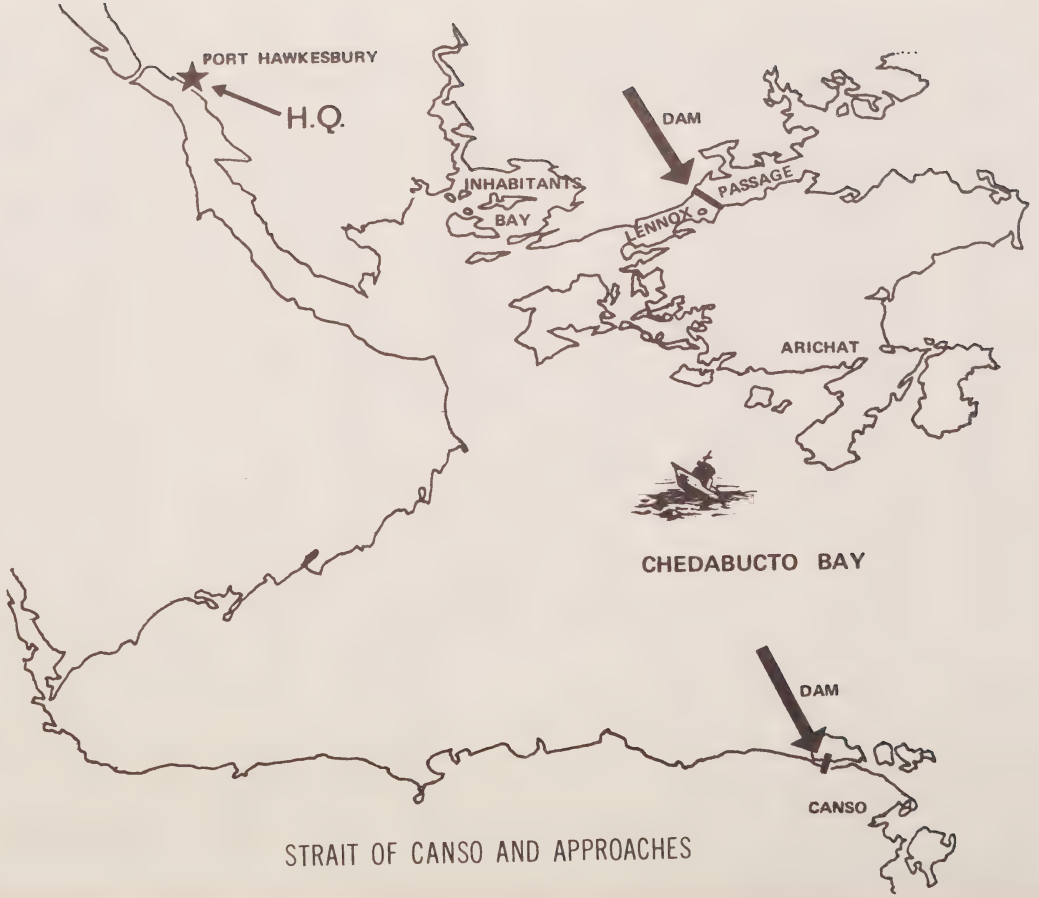
1. To deal expeditiously with the oil remaining in the wreck, the oil on the water, and the oil on the shore, in order to minimize the damage to the economy and the ecology of the region.

2. To summarize the findings in a report to the Minister with recommendations for future preparedness and actions required to prevent or cope with similar emergencies in the future.

The Task Force immediately proceeded to Port Hawkesbury, locating its headquarters at the Port Hawkesbury Motel.

The first job was to identify the problems and options (Figure2)*. It was vital to have all these worked on simultaneously, which required the rapid build-up of supporting forces equal to this task. While the Ministry of Transport provided ships, helicopters and administrative support and funding, and other departments provided specialists as required, it was mainly because of the quick reaction capability of the Canadian Armed Forces that it was possible to mobilize fully integrated headquarters and operational units within a few days. Such vital components as communications, a mobile control tower, ground transportation, logistics support, and a round- the-clock operations room were immediately made available by the military. About 80 soldiers, initially used in experimental operations and later mainly for the construction and installation of booms, were housed on the MOT vessel *Narwhal* and later on the Canadian Navy's *Cape Scott*.

* We were helped by the idea expressed on pp. 36 and 37 of *Oil Pollution: Problems and Policies,* edited by Stanley E. Degler, BNA.



STRAIT OF CANSO AND APPROACHES

In the early stages, about 80 per cent of the on-site capability was provided by the Canadian Armed Forces. The various Headquarters and Field Units are listed in the following table:

Headquarters Units	*Field Units*
Operations	Science
Administration	Debunkering Salvage
Communications	Oil Reconnaissance
Logistics and Transportation	Containment
Contracts and Finance	Floating Oil Clearance
Meteorology	Beach Clearance
Community Relations	Oceanography
	Fisheries
	Vessels and Helicopters

Headquarters

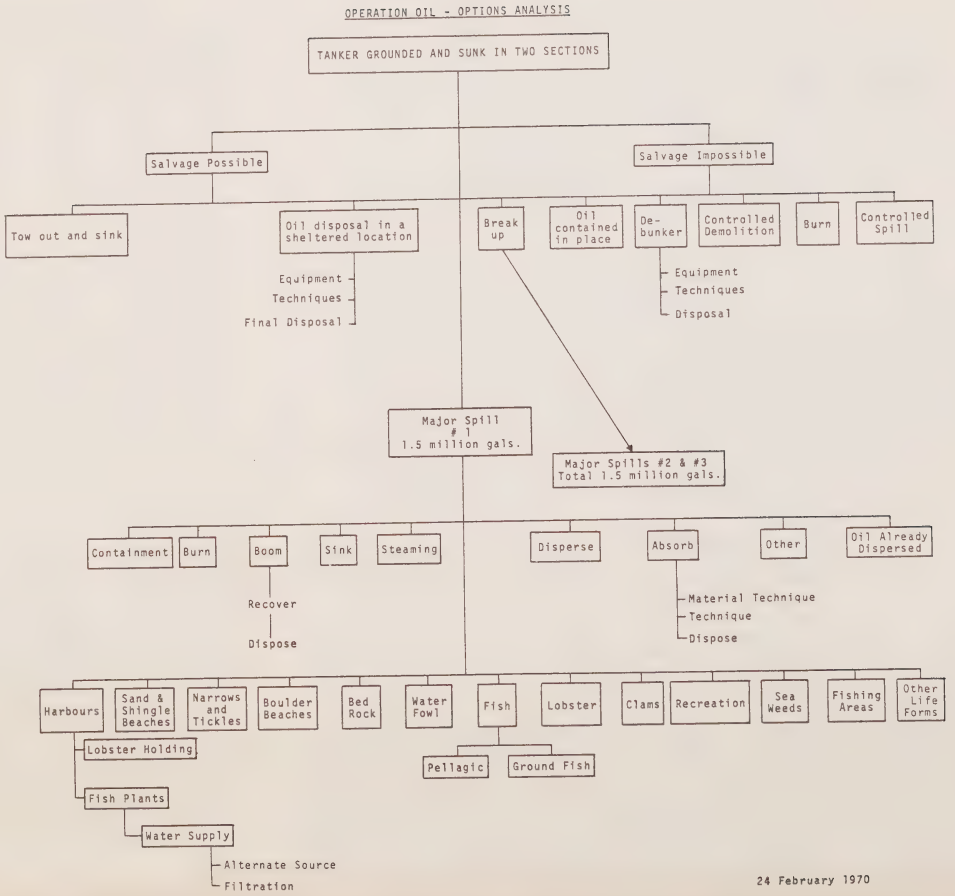
Most of the Headquarters units were organized and manned by the Canadian Armed Forces with the Ministry of Transport providing ships and helicopters and looking after Contracts and Finance. The *Narwhal* was used as a floating dormitory and when the *Cape Scott* took over the function, being a factory ship, it also provided workshops and technical expertise which were of vital importance to the operations. In addition to the *Narwhal,* the Ministry of Transport placed at the disposal of the Task Force two Coast Guard cutters, a fleet of LCM's, and other smaller landing craft, and two Bell Jet Ranger helicopters which were in constant use in oil reconnaissance and transportation to operational units. Two Fisheries vessels were provided by the Department of Fisheries. The Forces placed in operation a communications system capable of contacting ships, helicopters and land units as well as a telephone switchboard and network, and installed a mobile control tower for handling the Canadian Coast Guard's Jet Rangers and the Army's *Voyageur* which were used for transporting troops. A fleet of Army trucks was made available as well as a system of logistics support based on Maritime Command Headquarters which was connected to Task Force Headquarters by a "hot line" (see Vol. III, Pt. 1). A meteorologist and technicians on site provided continuously updated forecasts and micro-meteorology for the area (see Vol. III, Pt.2). Representatives of the provincial Emergency Measures Organization worked full-time for the Task Force, locating required equipment available in the Maritime Provinces and assisting in local and provincial problems.

Operations

General

Initial surveys of the Bay by the Task Force revealed the following urgent problems:

1. The area of operations consisted of about 1,200 square miles with some 375 miles of coastline, over half of which was contaminated in varying degrees. About 30 miles of the contaminated coast consisted of tourist and community beaches which had to be cleaned before summer.
2. The wreck still contained substantial quantities of oil which was slowly leaking and forming a continuous source of additional contamination.
3. Large quantities of oil were floating on the water and being driven back and forth across the Bay by the winds, providing fresh sources of contamination.
4. A hostile local environment developed by false rumours and considerable misinformation. Obviously it was necessary to establish good public relations immediately and provide the facts to the inhabitants of the area.
5. A conviction arose, which had to be dispelled, that it would not be possible to engage in the normal commercial fishing activities which were a major source of income to many of the inhabitants.


OPERATION OIL - OPTIONS ANALYSIS
TANKER GROUNDED AND SUNK IN TWO SECTIONS
Salvage Possible
Salvage Impossible
Tow out and sink
Oil disposal in a sheltered location
Equipment
Techniques
Final Disposal
Break up
Oil contained in place
De-bunker
Equipment
Techniques
Disposal
Controlled Demolition
Burn
Controlled Spill
Major Spill # 1 1.5 million gals.
Major Spills #2 & #3 Total 1.5 million gals.
Containment
Burn
Boom
Recover
Dispose
Sink
Steaming
Disperse
Absorb
Material Technique
Technique
Dispose
Other
Oil Already Dispersed
Harbours
Lobster Holding
Fish Plants
Water Supply
Alternate Source
Filtration
Sand & Shingle Beaches
Narrows and Tickles
Boulder Beaches
Bed Rock
Water Fowl
Fish
Pellagic
Ground Fish
Lobster
Clams
Recreation
Sea Weeds
Fishing Areas
Other Life Forms
24 February 1970

6. Four fish-packing plants, taking in large quantities of water from the Bay for their operations, were vitally concerned about the possibility of shut-down if oil entered their water intakes.

7. Areas such as upper Lennox Passage and the eastern end of the Canso Tickle were uncontaminated because ice bridges were holding back the oil. With the ice due to melt within two or three weeks, there was a great concern that these areas would become oiled, if not protected in some way.

8. Claims for oiled fishing gear would have to be paid unless the gear could be suitably cleaned.

9. Since this was the first time, to our knowledge, that a major spill of Bunker C fuel oil had occurred under near - Arctic conditions, many new scientific and technical problems had to be solved. Obviously, a large scientific organization was required to deal with urgent problems and to derive the maximum amount of scientific information from the incident to add to the world's storehouse of knowledge.

Community Relations

A Community Relations unit was immediately formed by the Task Force to establish contact with the fishermen and other local inhabitants and to provide daily reports to the news media. It was vitally important to place the facts before the public and inform them of the plan of attack and progress made. At its peak this unit consisted of four information officers (two provided by the Canadian Armed Forces and one each by the Ministry of Transport and the Department of Fisheries) and a staff photographer who maintained pictorial records of all operations. With a knowledge of the facts and evidence of positive action before them, the inhabitants changed their reaction from the initial marked hostility to one of sympathetic co-operation in a matter of a week or two. A novel method of imparting information to the community was through its children. For about six weeks, busloads of high school students were brought in nearly every day for briefings by members of the Task Force. Talks were also given to associations, service clubs, and other groups of interested citizens.

It is concluded that good community relations are essential in dealing with a disaster of this type, and that formation of a suitable PR unit should receive top priority in any future incident.

Science Organization

Another immediate reaction of the Task Force was to establish a back-up scientific organization based on the substantial pool of government and university scientists of all disciplines in the Halifax-Dartmouth area. Dr. W.L. Ford, Director of the Atlantic Oceanographic Laboratory, Bedford Institute, was named as the Scientific Co-ordinator. He established a team under four group leaders in the fields of Environmental Sciences (Physical), Environmental Sciences (Ecological), Chemical Science and Clean-up Technology. In addition, a Scientific Liaison Post was established at the Port Hawkesbury Headquarters as the direct link between the Task Force and the Scientific Co-ordination Team. Ultimately, over 100 scientists were working either full-time or part-time on immediate or long-term problems posed by the Task Force. In addition to the main group in the Halifax-Dartmouth area, other specialists from universities, industries and government laboratories across Canada responded willingly when requested for advice or assistance. Experts from the United States and the United Kingdom also acted as consultants.

To gain knowledge of the rate at which nature can clean contaminated beaches in this type of environment, a strip of untreated beach on the south shore of Crichton Island has been reserved for the scientists. This section of coastline, representative of the various types of beaches to be found in the area, will be observed periodically to follow the rate of change.

Some of the work of the Scientific Team is contained in this volume, but for details on all the areas covered the reader is referred to Volume II.

Oil Reconnaissance

Daily reconnaissance of the Bay, which was carried out by helicopters supplemented by ground survey and shipboard observations, was helpful in keeping all units aware of the day-to-day changes in the pollution problem. Very little progress was made in obtaining quantitative observations. The lack of an agreed nomenclature also detracted from the overall usefulness of this activity. However, even in retrospect this reconnaissance was essential but it needs substantial upgrading for the future (see Vol. III, Pt. 3).

Debunkering Operations

A team of Canadian Navy divers was requested to survey the wreck. They reported that the bow section was badly damaged and contained very little oil, but that the stern section was sitting relatively intact in an upright position on a gravel bottom. After review of all the options, the Task Force decided to attempt pumping the oil from the various tanks in the sunken stern section.

Captain S.A. Madsen, of Esso International, New York, had been consulted early in February by Imperial Oil. He had previously observed the use of "hot-tap" techniques in oil refineries and suggested that they might be useable under water. The "hot-tap" method is used to tap new lines into existing refinery lines without shutting down the flow. Imperial Oil prepared the necessary equipment which was successfully evaluated by the Canadian Navy divers in Halifax harbour.

At the request of the Task Force, Captain Madsen became Salvage Master, undertaking the responsibility of supervising the entire debunkering operation. Major facilities provided were as follows:

1. The Canadian Navy's diving tender, the *YMT 12*, with a team of 12 experienced divers.
2. The Irving *Whale,* an oil barge with a capacity of about 40,000 bbls. Two steam boilers were installed on the deck of the *Whale* to provide steam to heat the Bunker C oil in the wreck. As the water in the Bay was near the freezing point, the oil had by now cooled to temperatures well below the pour point.
3. The salvage vessel *Curb*, under contract by Murphy Pacific to the U.S. Navy obtained through naval channels.

Details of the operation are given in Volume III, Part 4, and the divers' report in Volume III, Part 5.

The divers attached flanges to the deck plates on all the intact tanks, using a Cox gun to drive threaded studs through holes in the flange into the deck. An 8-inch gate valve was attached to each flange and a hydraulic drill was lowered through the valve to cut a 7½-inch diameter hole through the deck. On removal of the drill, the valve was closed, an elbow was fitted to the valve, and a 6- or 8-inch flexible hose was attached and brought up to reciprocating pumps on the *Whale.* A steam trace of 1½-inch flexible metal hose installed inside the cargo hose was used to heat the oil by ejecting live steam through the gate valve. The technique was based on scientific experiments which demonstrated this to be the most practical method of providing heat under the circumstances. The Task Force cannot speak too highly of the heroic, willing and indeed enthusiastic response of the Canadian Navy divers, who worked under the most adverse conditions of cold, rough water and continuous contamination of their equipment by oil.

Frequent storms caused serious delays, in some cases necessitating removal of the *Whale* from its moorings and in others capping and dropping of the oil lines. To facilitate remooring, the divers carefully removed the funnel of the wreck with the use of explosives. A second attempt at removal of an obstacle with explosives was less

successful. Since a part of the superstructure did not permit free access of the long hydraulic drill to the tanks containing the ship's own bunker fuel, it was decided to remove the superstructure with explosives. By using only 4½ pounds of explosive, the obstruction was indeed removed, but the shock wave caused the lid of the centre tank to flip open, releasing an estimated 60,000 gallons of fuel. This brought into operation the contingency plan developed by the Task Force for such emergencies. Peat moss was spread over the surface of the resulting oil slick and unsuccessful attempts were made to burn up portions of the slick. A change in the wind caused most of the oil to be carried out to sea.

Pumping commenced on March 13 with rates of up to 150/ bbls./hour/line. By the time the operation was concluded on 11 April, about 37,000 bbls., or 1.3 million Imperial gallons had been pumped into the barge. To our knowledge, this was the first time oil had been pumped from a sunken wreck at depth. The material was shipped to Imperial Oil, Halifax, for removal of the water to restore the oil to a salable condition. It was estimated that about one third of the ship's cargo had been recovered, one third had been trapped in the Bay and was mainly on the beaches, and one third had been driven out to sea. Indeed, contamination of Sable Island, over 100 miles to the east, was identified as *Arrow* oil.

Subsequently, the divers have been recalled to seal the wreck, as well as possible, to prevent further leakage, The divers were also asked to shoot holes in the sides of the tanks with the Cox gun and determine the amount of oil remaining in the tanks with the use of probes. It was unfortunate that this technique had not been considered during the pumping operation, as it was discovered that upwards of 400 tons of oil remained in the stern section (no recoverable quantities are present in the bow section). The end point in the pumping out of each tank had been determined by a flow of water. After repeated pumpings in which substantial quantities of oil were left in the tank, is attributed to leaks in one of the hose couplings which gave a false indication of the tank being empty. In the case of the ship's port bunker tank, no oil flowed when the ullage cap was opened. We deduce this was because there was no sea pressure below the oil, because subsequently this tank was found to be more than half full. Another contributing cause is suspected to be clinging of the cold oil to the sides of the tanks. The Task Force has concluded that a second minor pumping operation is required, and Lieutenant-Commander D.B. Hope, who previously headed the diving team, has been assigned responsibility for this operation. A date of 1 September has been set as most suitable, since the water in the Bay will be at its maximum temperature by that time.

It is concluded that debunkering operations would be greatly simplified if "Madsen valves" or their equivalent were installed on all oil tankers. It is also concluded that further development of heating and pumping procedures is required to improve the efficiency of this type of operation.

Containment

1. *Lennox Passage Dam.* In order to protect the upper reaches of Lennox Passage from contamination, it was decided to dam the passage before the ice which was blocking the passage below the bridge melted. Under local contract, a continuous 24-hour-a-day operation resulted in the placement of 90,000 tons of rock-fill in less than two weeks.

The dam is in two sections with an island between. One section is about 1,400 feet long and the other about 900 feet. Since Lennox Passage is a navigable waterway, it will be necessary to open the centre section of the dam to allow the swingbridge to operate. Opening will not take place until there is no danger of oil movement up the channel from contaminated beaches.

2. *Canso Tickle Dam.* For similar reasons, a small dam was constructed across the Tickle (8,000 tons, 150 feet). The boulder beaches below the Tickle are heavily oiled and

some of the oil, heated by the sun, is flowing into the water. Until this is stabilized, it is not intended to remove the dam.

3. *Booms.* Commercial booms of many types were tested or used to prevent contamination of certain areas or to contain floating oil for subsequent removal. None of these was satisfactory in currents exceeding 1.5 knots, nor would they withstand rough seas and high winds.

A permeable boom was developed which operated successfully in currents as high as 6 knots and has withstood several storms. This makes use of empty 45-gallon drums as floats. Chain-link fencing was strapped between pairs of drums and to a heavy cable for tethering to the shore. Conifer boughs, interwoven into the fencing, were found to remove oil from the flowing water very effectively, while offering no appreciable resistance to the water. It was necessary periodically to remove heavily oiled boughs and to replace them with fresh material.

As a component of the Task Force's Contingency Plan, a seine net boom was developed for deployment between two fishing vessels to contain a large oil slick. The ¾ inch mesh net, 1,000 feet in length and 30 feet deep, has a float arrangement to provide sufficient freeboard and was quite capable of retaining the viscous cold Bunker C (see Vol. III, Pt. 6).

It is concluded that current booming technology leaves much to be desired and that further development work is required.

Water Supplies for Fish Plants

Four fish plants, the Co-op at Petit de Grat, Booth Fisheries at Petit de Grat, and Acadia Fisheries at Canso and Mulgrave, took in quantities of water from the harbour bottom ranging from 150 gals./min. for the smallest (Co-op) to 3,200 gals./min. for the largest (Canso). To ensure that the plants would not be shut down because of oil entering their lines, it was necessary to devise alternative sources of water supply or to develop suitable filters.

Mulgrave Plant. This plant was hooked up to the locally available freshwater supply.

Co-op Plant. A well was drilled and connected to the plant to provide an emergency supply of water.

Canso Plant. This plant could also be linked to the town's water supply but the rate of usage would drain the lake, which was the source of the water, in a few days. With the co-operation of the provincial Water Resources authorities, stand-by plastic piping and pumps were made available to tap into neighbouring lakes within two days, if required.

Booth Plant. No alternative source of water was available. Accordingly, an in-plant filter was developed and installed within three weeks, through which the intake water could be by-passed in an emergency. This gravity-flow filter unit makes use of polyurethane chips on top of large discs of polyurethane foam and was of high efficiency (see Vol. III, Pt. 7). On 1 April, oil did appear at the intake into the plant and the filter was placed in operation successfully. The oil was subsequently traced to the deposition of oiled seaweed on the harbour bottom. This weed was later removed with the use of Irish Moss rakes.

Ecology (see Vol. II for details)

Bunker C oil is relatively non-toxic and the use of chemical dispersants, which created serious toxicity problems in the *Torrey Canyon* incident, was avoided. Fisheries Research Board divers conducted repeated transects of the floor of the Bay and found that the bottom life was unaffected by the spill. Consequently, the lobstering season opened on schedule and the catch has been normal. The herring catch has been above normal.

Some effect on organisms in the intertidal zone has been noted. In particular, it was necessary to close down clamming activities which are, in any case non-commercial in this area. In May there was a 25 per cent kill of clams owing to suffocation caused by plugging of their airholes by oil. A month later there were no deaths in clams recovered.

It is estimated that about 2,300 birds died because of oiling in Chedabucto Bay. In addition, 4,800 were killed in the region of Sable Island. While these kills are most regretable, the Wildlife authorities assure us that no serious long-term effects on any particular species will result.

A few seals died of heavy oiling. Problems were experienced with sheep feeding on oiled kelp - not through consumption but by contamination of the fleece.

It is concluded that, despite the relatively large amount of oil released from the wreck, the overall or lasting effect on the wildlife and fishlife in the Bay was not significant.

Cleaning of Oiled Fishing Gear

Shortly after the grounding of the *Arrow*, four purse seine nets were seriously contaminated. These nets are nearly half a mile long and 300 feet deep, weigh 11 tons, and cost about $25,000 each. To avoid paying such large claims, the scientists developed a "laundromat" which was manufactured and installed within three weeks from the original request. This device consists of three tanks, the first lined with steam jets, the second containing diesel oil and an emulsifier, and the third providing a hot water wash. The nets were drawn through the tanks by means of a power block similar to those used on the seiners. Each net was cleaned in this way in about six hours, to the satisfaction of the fishermen. This development, costing about $22,000, was considered to be a very cost-effective venture. In addition, lobster pots, lines and floats, gill nets, booms and a variety of other equipment were cleaned in the "laundromat". Details are given in Volume II, chapter 8.4, and Volume III, Part 8.

Removal of Floating Oil

Within a few hours, oil floating on rough water picks up considerable quantities of water, In this case, the weathered Bunker C oil at temperatures near the freezing point of water formed water-in-oil emulsions containing, in most samples, 40 to 50 per cent of water and still black in coulour. Only in one or two isolated cases was material observed that could be labelled as the well-known "chocolate mousse" (60 to 70 per cent water). These emulsions, black or brown, were extremely viscous and difficult to handle. The following methods of dealing with floating oil were considered or used:

1. *Absorbents.* Tests at the University of Sherbrooke revealed that, of the natural absorbents available, garden-type peat moss is superior in terms of oil absorbed/unit weight of absorbent; for example, it is considerably better than straw which has been commonly used. Accordingly, stockpiles of peat moss were located at strategic points around the Bay for use in a contingency and, as noted above, the material was used in quantity on the oil slick produced by the accidental spill. The peat moss was applied to make recovery of the oil easier when it reached the shore. As noted, the slick went out to sea and, it is believed, was expedited in its movement by the peat moss on the surface acting as a "sail". Peat moss is of value only when applied to fresh oil, having little absorbent properties for the weathered emulsion. Tests revealed that a commercial product, believed to be a type of fibrillated polypropylene, has the highest absorbency of all materials tested, but it is also considerably more expensive. Research is required to determine the cost-effectiveness of the various absorbents available in different applications (see Vol. III, Pt. 9).
2. *Burning* (see Vol. II, chap. 6.5 for details). For oil slicks on the open sea, one of the most attractive approaches to the removal of the oil is by burning. There is little hope of burning slicks which have been exposed to weathering for more than a few hours, since vast quantities of heat are required to drive off the water from the emulsions before ignition is possible. For fresh spills, burning may be feasible, In one experi-

ment in the North Sea, 10 tons of fresh Arabian Crude oil were destroyed by burning by using a sodium - calcium carbide product called Kontax, produced in Germany. This material was successfully used to ignite a small fresh Bunker C spill in an experiment in Chedabucto Bay but, the method of application leaves much to be desired for large slicks. Corning Sea-Beads were also used experimentally and under ideal conditions did induce ignition, but the method is not considered practical on a large scale. More research in burning techniques is required.

3. *Sinking Agents.* Materials are available, such as chalk or sand chemically treated to render them oleophilic, which, when sprayed on an oil slick, cause it to stick to the bottom. Such materials were not used in Chedabucto Bay because of the hazard of fishing gear contamination, the possible damage to bottom fauna and flora, and the possibility of subsequent rise of some of the oil. It is believed that further work is required on the fate of oil treated in this way before serious consideration is given to the use of sinking agents in future spills.

4. *Dispersants.* Although considerable testing and evaluation were performed on a number of commercial dispersants (see Vol. II, chap. 6.7), these materials were not employed on a significant scale in Chedabucto Bay mainly because of the hazzard of toxicity to marine life. Aside from the problem of toxicity, one must question the advisability of getting the oil out of sight by dispersing it through the water column, and further work on the possibility of reagglomeration is necessary. The trend in current commercial dispersants is in the direction of greatly reduced toxicity by lowering of the aromatic solvent content, but this in turn reduces the dispersing efficiency, particularly for heavy or weathered oils. It is believed that modern dispersants may have a place in the overall contingency plan, but only after toxicity, efficiency, cost-effectiveness in comparison to other techniques, and the fate of the dispersed oil are all studied in great detail.

5. *Mechanical or Surface-skimming Devices.* After initial tests indicated that it was capable of handling the very viscous floating oil, the device that was used extensively in Operation Oil was the Oilevator or, as it has become commonly known, the "slick-licker" (see Vol. III, Pt. 10). It consists of a 3-foot wide continuous conveyor belt which dips into the surface; oil adheres to the oleophilic surface of the belt while water runs back down so that oil with very little water comes off the upper end of the conveyor into suitable containers. Three slick-licker units were manufactured, and the prototype was suitably modified to handle the heavy oil, with added rollers, positive chain drive, etc. Three were mounted on small landing craft and the other on a catamaran specially designed for this operation. The oil was collected in plastic bags inserted in 45-gallon drums which were transferred by crane to an LCM, then off-loaded onto trucks and transported to dumpsites approved by provincial authorities. Each slick-licker is capable of removing about 40,000 gallons of oil/day under ideal operating conditions such as provided by a thick slick. Since by the time these devices were placed in full operation large slicks were no longer present, they were used to pick up oil and oily weed along the edge of the shore in areas such as Inhabitants Bay which acted as a catch-pool. Two to three thousand gallons of such material were collected each day over a period of ten weeks. These devices commend themselves for simplicity, low cost, and ease of operation. Many types of commercial "skimmers" are under development or becoming available. Most of them take in large quantities of water along with the oil and thus require centrifuges or other separating devices which add to the cost. Those that look most promising, through vortex action or by lowering the level of water in a contained area, form deep pools of oil which can be pumped. Continuing evaluation of such devices as they become available is recommended.

6. *Oil in Ice.* In the initial stages of the operation, much of the shore-fast ice and broken ice collecting along the shore was dark in appearance and contained dispersed oil. At first, truckloads of this material were carted away to dumpsites, but this practice was discontinued when analysis showed that the oil content of the ice varied from 0.5 per cent to a maximum of 4.5 per cent.

Jetty Cleaning

It was required to clean fishermen's jetties which were badly contaminated and would, in turn, contaminate their boats. After a number of experimental approaches, including the use of high-pressure water jets, it was decided that steam cleaning would be most efficient and least costly. our steam generators were mounted on the catamaran and, with two steam jets operating on each side of a jetty, cleaning could be accomplished in a few hours. The oil removed was collected on floating peat moss inside a net boom and then picked up by dip nets. Fifty-eight jetties and wharves were effectively cleaned in this manner.

Beach Clearance

Since the use of chemical dispersants for beach cleaning was dismissed for reasons given in the above discussion of dispersants, the only practical methods remaining were the removal of contaminated material by mechanical equipment or manual labour. In addition, certain limited areas of rocky foreshore were cleaned with the use of steam jets. when this work is completed by mid-September, approximately 30 miles of tourist and community beaches will have been cleaned, with the remaining shore contamination left to weather naturally. Biodegradation experiments using organisms native to the environment will be conducted to determine the rate of clean-up via this mechanism.

A complete spectrum of beach types exists around the Bay, ranging from good sand beaches to gravel and shingle, and rock and boulder beaches. Oil clings tenaciously to bedrock and boulders but begins to flow when heated by the sun, creating a re-oiling problem which has been serious in some areas. Some stabilization has been achieved with the manual application of oil in these areas (see Vol. II, chap. 8.2)

Continuing advice has been received from coastal geomorphologists on the sensitivity of the various beaches in order that appropriate methods of removal of contamination might be used in each case. Large quantities of material can be removed from those beaches which replace themselves very readily. Others can be permanently destroyed if treated in this manner. These, plus the extent of contamination, were the criteria that governed the method of attack at each location.

The relatively lightly contaminated beaches along the Bay of Rocks and east of St. Peters Bay were cleared of patches of oil and oiled weed by hand. Flying squads of labourers, nicknamed "slick-pickers". were hired for this purpose, about 120 being the maximum number at the peak period. Slick-pickers also worked in many other suitable locations around the Bay, removing many tons of material which was trucked away to approved dumpsites.

A variety of mechanical equipment, including bulldozers and front-end loaders, was employed under local contract to remove heavily contaminated layers from appropriate areas. Thousands of tons of beach material were removed by these procedures. Development of improved devices for the removal of contamination from beaches with minimum beach damage is required. A summary of beaches cleaned, tonnage removed, and costs will be given in a supplementary report after the work is completed.

PART 4 - COSTS

In presenting the report on costs of Operation Oil, it is necessary to differentiate between *out-of-pocket* costs on the one hand and *total* costs on the other. The out-of-pocket costs are the summation of the direct cash flow on the purchase of goods and services which the Government would not otherwise have made. The difference between this and the total cost of the operation therefore includes the salaries of all military and civilian personnel already on the federal government's payroll plus a large amount of Canadian Forces flying, Canadian Coast Guard flying, Canadian ship time, etc. which, it could be argued, was going to be done anyway but for other purposes. The difference also includes the salaries, overhead and indirect costs of the scientific component of the operation. These are estimates only because the cost of calculating an accurate figure did not seem justified in the light of the use likely to be made of it. If our judgment in this is wrong, an accurate figure can be obtained at the cost of a large number of accountant man-hours.

That these costs are a legitimate charge against Operation Oil we suggest is irrefutable because they are built up from a series of judgments made by the Task Force as to whether to use federal government people and resources or whether to buy the goods and services needed from the private sector. The fact that the decision was made on the basis of availability, speed of response to our needs, and efficiency, and not as a cost-saving device, does not, we suggest, alter the principle.

Not included in these figures are the penalties which arise because the people concerned with Operation Oil are not doing those things which they would normally have expected to do during the period. For example, without wishing to argue for any particular attributes of the Chairman of the Task Force, his position as Executive Director of the Science Council of Canada was virtually vacant for four and a half months and, as a result, the work of the Science Council did not progress at the speed originally planned.

As another example, all the hundred and more scientists who worked on our problems were all busy on problems of their own before the Task Force called on them to help. All this work of their own was delayed. It is impossible to put a dollar cost on these penalties but they are real and have to be absorbed by the nation whose shores were polluted.

There are certain ongoing activities in Operation Oil wherein actual costs are not yet available. We have, however, included in Table 1 an estimate of the cost of these activities to completion.

The out-of-pocket costs for the services of the *Curb* are high. Had the *Cape Scott* been available at the outset, she could have done a better job as a factory ship. She would have had to be supplemented by a tug, but this would have been available from Canadian sources. The total cost would then have appeared to be less because the out-of-pocket costs would have been substantially reduced although the total cost would have been of the same order of magnitude. It is stressed that the *Curb* was brought on site because of her on-board manufacturing and salvage capabilities and immediately available expertise. The fact that she could behave like a tug and manoeuvre the Irving *Whale* was a dividend.

The cost of containment and recovery of the oil on the water should not be taken as indicative of likely costs on subsequent occasions. Had we reached a decision on the use of the slick-lickers earlier, and had they been immediately available instead of having to be manufactured, we would have recovered substantially more oil than was the case because we could have got it as the ice melted. Had the technology and the manufacture of booms capable of withstanding Chedabucto Bay conditions and retaining oil been

available in the present form from the outset, areas whose shores are now fouled could have been kept clean.

The cost of beach cleaning is low because the inhabitants of Chedabucto Bay were very modest in their identification of community beaches. The population seemed to identify well with the problems facing the Task Force and seemed to seek ways of making the task less difficult. Indeed, the fact that only 30 miles of beach had to be cleaned to meet the needs of the tourists and the people residing in the Bay is a tribute of their understanding and consideration. In other parts of Canada there could well have been insistence on cleaning a much greater proportion of the polluted shoreline.

The various costs could be broken down in a variety of ways to satisfy a variety of concerns. While some costs can be clearly allocated by purpose, i.e. debunkering, recovery of oil from the water, beach cleaning, etc., there are other costs that are common to the whole operation and any proportioning of them among the various primary objects would be completely artificial.

When comparing the costs of this operation to estimates of others, it must be borne in mind that we were operating in a cold environment. In particular, with respect to the debunkering operation from the stern section of the *Arrow*, the water temperatures were around 0° Celsius and the air temperatures varied from -180° to -5° Celsius. Twelve inches on new sea ice formed within the first two weeks of our operation. Storms occurred every two or three days, and the combination of snow and high winds and rough seas slowed the work of the salvage crew, the divers and those working on the barge. Frequently it was necessary to cease operations and on several occasions to blank off the hoses and lower them onto the deck of the wreck. On three occasions the *Whale* had to be removed from its four-point mooring. These interruptions and delays were as costly as they were frustrating.

Out-of-pocket Costs

The following is a breakdown of known costs to date and our estimate of funds that may be required to complete the operation.

1.	COSTS TO JULY 15, 1970		
	a) Materials, services, etc. including Lennox Passage Dam	$812,402.08	
	b) Payments for hire of *Curb*	246,521.88	
	c) Payroll costs	129,714.92	
	d) Inter-office transfers	39,158.37	
	e) Payment to National Film Board	12,000.00	
	f) DPW contracts for beach cleaning	72,493.00	$1,312,290.25
2.	OTHER ESTIMATED COSTS TO SEPTEMBER 30, 1970		
	a) Defence Research Board, excluding personnel and ship	$12,717.26	
	b) Estimated expenditures by the Department of Energy, Mines and Resources	180,000.00	
	c) Estimated extra payments to be made for *Curb*	246,012.39	
	d) Estimated additional funds to continue beach cleaning	38,000.00	
	e) Estimated additional funds to complete slick-licking	40,000.00	

f)	Estimated cost of removing residual oil from *Arrow*	50,000.00	
g)	Estimated cost of extra materials, services, etc.	15,251.70	
h)	Estimated cost of opening Lennox Passage Dam	26,000.00	
i)	Estimated cost of removing Canso Tickle Dam	4,000.00	$ 611,981.35
			$1,924,271.60*

Total Costs

We have received from MOT Marine Finance Branch an estimate that the total cost will be approximately $3,100,000.00.

Major Unit Costs

The following approximate unit costs may be of interest:

1. Filter for Booth fish plant, Petit de Grat	$ 15,000.00
2. Canso Tickle Dam	6,800.00
3. Laundromat	22,500.00
4. Lennox Passage Dam	161,100.00
5. Contingency seine net	4,800.00
6. Slick-lickers (3 new and 1 rebuilt)	13,100.00
7. Hydraulic hot tapping machine	6,900.00

* This figure includes some recoverable costs through material returned to MOT stores and placed in the temporary contingency compound in Halifax available for future use.

PART 5 - OTHER SPILLS

At the time we proceeded to Chedabucto Bay, on February 20, we already had knowledge of and a responsibility for a spill by the Irving Oil Company barge, the *Whale*, near the Burin Peninsula. The purpose of this part of our report is to highlight the frequency with which petroleum spills are taking place in Canada, in the hope that by documenting this we will bring the weight of both government and public opinion to bear on a situation which can and should be corrected. Not that spills in the petroleum industry can be eliminated any more than one can eliminate spills in one's own kitchen. But if spills in a kitchen were as frequent as spills in the oil industry, our homes would be pigsties. The following is a catalogue, then, of "other spills" in Canada which came to our attention during the course of Operation Oil. Comments are provided only in those cases where we had direct knowledge or involvement.

1. *Burin Peninsula.* Bunker C, amount unknown, but probably in excess of 3,000 gallons. By the time we were on site the oil had moved onto the rocky shore of Burin Peninsula. Two thousand five hundred birds had been killed, but the oil was no longer a hazard to the ecology. Apart from a survey, no action was possible.
2. *Sydney Harbour.* Amount unknown. Source, a Greek tanker delivering Bunker C.
3. *Halifax Harbour.* (Two)
4. *Magdalen Islands.*
5. *St. John's Harbour.*
6. *Digby Harbour.*
7. *Sinking of Patrick Morris.* (500 tons of Bunker C in the ship's bunkers.) Over 100,000 gallons at the time the ship sank. This oil came to the surface and was tracked by Operation Oil personnel onto the sand beach in front of Big Glace Bay Lake, Cape Breton Island. Owing to the prompt action of Canadian National Railways forces, assisted by expert instruction and peat moss from Operation Oil, the situation was dealt with on a real-time basis and shore pollution did not occur to a significant extent.
8. *St. Croix River.*
9. *Irving Oil Company at the Town of Canso.*. Primarily a leaking transfer line, from the Irving Oil Company tank farm to the fish plant, and subsequently leaking from an underground pool to Bunker C from a previous spill, reportedly owing to an explosion in the fish plant. Remedial action by Irving Oil Company, once the leak was detected, was inefficient and slow. As a result, the leaking situation persisted for over a month when the matter should have been cleaned up in a few days. The Irving Oil Company seemed more intent on trying to prove that they were not responsible than on cleaning up the source, even though there was no other supplier of Bunker C in the Town of Canso and therefore the only possible argument could have been whether they or their customer, the fish plant, owned the oil at the time it was released.
10. *Deception Bay.* 367,000 gallons of diesel oil and 57,000 gallons of gasoline from shore tanks displaced by a landslide.
11. *Athabaska River.* A large spill from a fractured pipeline.

It is stressed that these are only the spills that came to the attention of the Task Force during the first five months of its operation. We have seen press records of small spills in the Muskoka River in Ontario and in the river draining out of Lake Louise in the

Canadian Rockies. We are sure there are hundreds of other spills, causing annoyance or inconvenience to a small number of people, which go unreported.

From our own observation, very few storage tanks for petroleum products in the Province of Nova Scotia, other than the very large tanks, have dykes around them of any sort, let alone dykes sufficient to contain the complete contents of the tank. We would urge that provinces enact and enforce regulations requiring dyking of adequate proportions to contain the entire content of the tank around each commercial storage tank for bulk petroleum products.

Most of the harbour spills are the result of carelessness in either loading or unloading. The folklore of deck officers is replete with stories of spills because the man who was supposed to be watching the operation with his hand on the valve had gone off for a smoke, gone off for a drink, or was sound asleep. We suggest that it is essential that all loading and unloading operations of petroleum products be continuously monitored at both ends of the transfer pipe during the entire loading and offloading operation, and that it be mandatory that a spill, should it occur, be reported immediately, regardless of the size of the spill. The present tendency is to attempt to cover up the fact of the spill as quickly as possible and then to deny all responsibility therefor. In addition to a change in legislation, a policing action will be necessary and a requirement to deliver to the department samples of the oil loaded. A positive program of petroleum "fingerprinting" would, we suggest, be a suitable deterrent and, at the same time, provide the legal evidence for conviction of those who refuse to respond to guidance.

The positioning of bulk storage tanks on shore should similarly be subject to authorization from a competent government body. We have not investigated the legal status of this in all provinces. All we can say is that, if the regulations exist, they are not being enforced in several provinces of which we have knowledge.

If pipelines are laid for engineering and cost reasons along watercourses, then as a direct cost of installation there should be a requirement for dykes of sufficient magnitude to contain a spill of the contents of the pipeline between valving stations.

PART 6 - CONCLUSIONS AND RECOMMENDATIONS

Definitions and Nomenclature

There is a distressing lack of standardization in the literature in the use of both normal English words and specialized terms to describe the various observable phenomena and parameters connected with spills of oil or other hazardous substances. It is similar to the international state of affairs regarding ice in navigable waters immediately after World War II. As a result of ongoing international co-operation an agreed nomenclature for ice in navigable waters has to a very large extent been reached. *We therefore recommend that Canada should take the initiative with the appropriate international bodies to seto seek agreement on a series of definitions and descriptions that will permit the reporting of spills in an orderly and understandable manner.*

To present an example of the problems faced at the present time, the term "oil slick" is applied to everything from a small patch of iridescent oil a few square feet in area and around 3/100,000 of an inch thick to an area of Bunker C several square miles in area and several inches thick. Those people who have witnessed the latter conjur up visions of these veritable seas of oil every time the term oil slick is used, whereas those who have not seen a major spill use the term oil slick for the kind of trail left in the wake of an outboard motor. We have faced these problems in attempting to communicate among people even in the limited area of Chedabucto Bay. On a world-wide basis the misunderstanding and misinterpretation is very substantial.

For this present report we will use the following definitions of spills which were taken directly from the National Oil and Hazardous Materials Pollution Contingency Plan which was released by the Council on Environmental Quality of the Executive Office of the President of the United States on the 1st of June, 1970. We suggest that these terms be used in Canada until or unless they are modified by international agreement. We have no specific recommendation to make on oil slick nomenclature other than that the terms must be tied in a quantitative way to the area covered by the slick and its thickness.

(1) *Pollution Incident* - is a spill, including an imminent threat of spill, of oil or other hazardous substance of such magnitude or sugnificance as to require immediate response to contain, clean up or dispose of the material to prevent a substantial threat to public health or welfare, which includes to fish, shellfish, wildlife, shorelines and beaches.

(2) *Oil* - oil of any kind or in any form, including, but not limited to, petroleum, fuel oil, sludge, oil refuse and oil mixed with wastes other than dredged spoil.

(3) *Hazardous Substance* - is an element or compound, other than oil as defined in (2) above, which when discharged in any quantity into or upon the navigable waters of Canada or adjoining shorelines or the waters of the contiguous zone, presents an imminent and substantial danger to the public health or welfare, including, but not limited to, fish, shellfish, wildlife, shorelines and beaches.

(4) *Minor Spill* - is a discharge of oil of less than 100 gallons in internal waters, or less than 1000 gallons in offshore waters, or a spill of small quantities of other substances. Discharges that (i) occur in or endanger critical water areas; (ii) generate critical public concern; (iii) become the focus of an enforcement action; or (iv) pose a threat to public health or welfare, should be classified as moderate or major spills depending on their degree of impact.

(5) *Moderate Spill* - is a discharge of oil of 100 gallons to 10,000 gallons in the internal waters of 1000 gallons to 100,000 gallons in offshore waters, or a discharge of any material of any size that poses a threat to the public health or welfare.

(6) *Major Spill* - is a discharge of oil of more than 10,000 gallons in internal waters or more than 100,000 gallons in offshore waters or a discharge of any size of such nature and quantity that human health or welfare are substantially threatened.

(7) *Potential Spill* - is any accident of other circumstance which threatens to result in the discharge of oil or other hazardous substance. A potential spill shall be classified as to severity based on the guidelines above.

Prevention and Control

International

We are appalled at what we have heard and seen during the course of Operation Oil with regard to the operation of the world's tanker fleets. There are unquestionably many fine masters of tankers who have highly qualified crew, who operate their ships with prudence and a regard for others, and have ships that are well maintained, with adequate equipment. But the operation of the so-called "flags of convenience", representing over a third of the world's total tonnage of tankers, is at the other end of the spectrum, and is exemplified by the *Arrow*, which was operating with almost none of its navigation equipment serviceable and with no navigation skills resident in any of the crew with the exception of the master, and there are even doubts about his ability.

Even with regard to the operation of non-tankers, it would appear that far too many masters are still living in the days of sail and go blindly ahead at full speed with none of their navigation equipment working. Unreasonable pressures brought to bear on masters by the ships' owners concerned only with profits are an important factor in this problem.

We also find that with very few exceptions international law in marine matters seems to be written to protect the mariner and his ship from being molested by hostile natives at the ports at which he calls. This too may have been valid a century ago, but if the appalling safety record of tankers is to be drastically changed and the rights of those who stand to suffer from unnecessary marine accidents are to be protected, an entirely new approach to an international maritime convention will have to be taken. *Accordingly, we recommend that consistent with the initiatives taken by the Government with respect to Arctic pollution and at the IMCO special conference on pollution in 1969, Canada take a parallel initiative to convene a conference of all those concerned to write a new international convention for the operation and control of shipping throughout the world and that this convention be patterned on the principles of the Convention on International Civil Aviation.*

Canada had a significant role in the writing of the Convention on International Civil Aviation in Chicago in 1944, and while the International Civil Aviation Organization has brought in many improvements since that time, the main thrust of the Convention remains and has resulted in a world safety record of international aviation of which the world can be justly proud. It should be remembered that flying aircraft safely is infinitely more difficult than sailing ships safely. Aircraft operate in three dimensions, ships in two. We feel that if the principles embodied in the civil aviation convention are transposed into a marine convention, the same enviable safety record can be achieved.

We also recommend that the convention should ban all deliberate pumping of oil, oily waste or tank cleanings, or bilge cleanings into the oceans or any other body of navigable waters. Far too little is known about the natural degradation of oil in these environments to justify a continuation of these practices. The fragmentary reports now being received from those who have traversed parts of the Atlantic and found large aggregations of lumps of degraded oil should be taken as warning that the world's shipping may be exceeding the natural capability of the oceans to cope with this type of pollution. We suggest that the alternatives open to ships should be to pump their bilges and their oil-contaminated cleanings into shore tanks specially provided for the purpose or to install in-line equipment that will extract the petroleum products and dump clean water. We

also suggest that the loading-on-top principle for tankers should be made mandatory and policed.

National Legislation and Practice

We do not underestimate the patience and perseverance that will be necessary to achieve the foregoing international accord, but the substantial elimination of oil pollution we suggest is an urgent national matter. Canada should enact laws and establish practices to protect Canadians and to lay down standards for the transportation and handling of petroleum products which will effectively bring some much needed discipline into this area.

We have not made a study of existing federal and provincial legislation but from our observations in Nova Scotia any that does exist is neither being applied nor enforced and the penalties for non-compliance do not appear to act as a sufficient deterrent. For example, it would appear that there are few convictions of ships' masters for deliberately or carelessly dumping oil in the water, and on those occasions when convictions are obtained, the fine seems to be far too small to be considered as anything more than a flea bite on the tanker elephant.

Also, there were no dykes around the Irving Oil Company tanks at Canso town and we saw a number of other bulk storage tanks for petroleum products throughout the province that were not protected by dykes. It would also appear from the partial information we have received on the Athabaska spill that there was no dyke between the pipeline and the river.

We recommend that

1) *with respect to tanker operations, in order to enter Canadian waters they provide evidence that they are itted with adequate and serviceable navigation equipment*

2) *Canadian pilots be required on all vessels entering Canadian waters unless the ship and its captain have been given special clearance by the federal authority*

3) *standards of competence of crews of ships entering Canadian waters should conform with our national standards*

4) *the same principles as in 2) and 3) above should apply to Canadian ships in Canadian waters*

5) *there should be a compulsory filing of samples of all petroleum products loaded on ships and a requirement that any spillage of petroleum products regardless of whether they originate from a shore tank or a ship be immediately reported and sampled*

6) *the federal government establish one or more central laboratories capable of "fingerprinting" petroleum products in a manner acceptable to the courts.*

It is likely that gaschromotography analysis will be adequate but analysis based on neutron activation is being developed as a possibly more rigorous substitute if legal opinion requires it. Every sample left by every ship would not be examined but when a spill occurred and there was an argument or a denial of responsibility, as now frequently arises, the analysis could establish the guilty party without doubt. The sheer existence of such a fingerprinting would act as a major deterrent and of course the primary goal must be the elimination of such pollution incidents rather than the punishment of the offender. It is still almost unbelievable to us that a ship passing Cerberus Rock in June 1970 would deliberately pump its tanks or its bilges and as a result re-oil a beach in Arichat that had just been cleaned.

We recommend

1) *that all bulk storage tanks holding petroleum products or other hazardous substances be protected by dykes capable of containing the entire contents of the tank*

2) *that pipelines running along water courses be similarly dyked.*

With regard to pollution control zones we have noted the discussion following the Government's announcement of the 100-mile zone in the Arctic. The *Arrow* oil travelled over 100 miles from Chedabucto Bay and polluted the shores of Sable Island.

We recommend that extensive pollution control zones be established to cover the rest of the coast of Canada consistent with the position taken by the Government in the Arctic.

Industry must recognize that those that pollute must pay the cost of cleaning up. We realize that the insurance companies are finding some difficulty in conceptualizing this problem to the point where they are prepared to insure against it, but it is a simple direct problem that is not going to be solved by tokenism such as that being practised by TOVALOP. Certainly the industry has a right to expect that governments will not be extravagant in their clean-up costs, but at the same time industry has no justifiable basis for limiting its financial responsibilities for the ignorance or carelessness of its operations.

We recommend that the law should make it clear that those who pollute pay the complete cost of clean-ip, including the cost of any Canadian federal or provincial personnel used in the clean-up, that the ship concerned be impounded until this has been accomplished or assured and that the legal penalties be in addition to this liability for the complete cost of cleaning up the pollution.

Federal Responsibilities and Authorities

As far as we have been able to determine, seven departments of government have a declared or implicit interest in the pollution of water by oil or other hazardous substances. These are the Ministry of Transport, the Department of Energy, Mines and Resources, the Department of Fisheries and Forestry, the Department of Indian Affairs and Northern Development, the Department of National Health and Welfare, the Department of National Defence and the Department of Public Works. The presently popular way of resolving problems of multi-departmental interest is to establish a committee. We submit that no committee can deal effectively with an oil spill of any magnitude.

We carry no brief for the ratio of successes and failures in our own operations but we do hope that if there is another major spill in Canadian waters those responsible for the clean-up will be able to do a better job because of our experience and recommendations.

We are of the firm opinion that the only way that oil spills are going to be cleaned up effectively, when the responsibility rests at the federal level, is to have a small task force such as ours given the full responsibility and the authority to deal with it. The task force must, as it was in our case, be responsible to a single minister. It is a pleasure to record that given this situation the co-operation we received from all other departments and the co-operation we received at the provincial level was instantaneous and outstanding.

On the basis of these experiences *we recommend that the Minister of Transport have the responsibility for dealing with pollution arising from oil spilled in water when the extent and nature of the spill makes it a federal responsibility.* The other departments will have major or minor contributions to make to the resulting operations and will have major or minor responsibilities for the immediate and ongoing research depending on the nature of the substance and the magnitude of the spill and the geographical and climatic régime in which the spill takes place.

*We recommend that this responsibility of the Minister of Transport be focused in a small team at the headquarters level and comprising a minimum of one physical scientist, one biological scientist and one operations expert, with the physical scientist being the leader.*This team would have direct responsibility for any spill and would exercise that responsibility on behalf of the Ministry on a completely feudal basis if they saw that the people who would normally be expected to deal with the situation were not making satisfactory progress. Their judgment should certainly be challenged post facto, but only by the Minister or Deputy Minister of Transport during the actual operation.

This team would be responsible for maintaining Canada's preparedness at a level

reflecting the latest knowledge and experience throughout the world, and in particular for ensuring the adequacy of contingency plans and contingency equipment in the various key geographic areas.

In carrying out this work they will need strong scientific support and we feel strongly that this should not be created within the Ministry of Transport. We feel that the scientific competence already in the other five departments is adequate to reflect the internal research which the Government should undertake, and in fact substantial emphasis should be placed on the desirability of contracting to industry and to universities a major portion of the research needed to ensure Canada's preparedness.

It is also stressed that it is not necessary for Canada to carry out research in the full gamut of problems that have been identified in our experience with Operation Oil. Strong and ongoing liaison should be established in the research area on oil pollution problems with the United Kingdom, U.S.A., France and Sweden, in particular, and most probably with the U.S.S.R. Though we have found few references to Russian work in this field, we consider this is probably a limitation of our own library searching capability and not an absence of study on these matters within the Soviet Union.

There will be certain problems of major concern to the Ministry of Transport team that are being adequately researched in other countries and the in-Canada support they will need in these items is assistance from the scientific community in assessing the impact of the research of others. There will be other areas of special significance or where Canada climatically has a special advantage where the research in these areas should be mounted within Canada. *We recommend that the scientific advice required by the headquarters team in the Ministry of Transport be provided by a group actively concerned with a portion of the research themselves. This advice will include assessment of research done in other countries, assessment of proposals for research to be carried out in Canada, and advice on grants to universities and industry to involve them in research, development and innovation in this area of pollution and its prevention. We feel that at the present time the best group to perform this function is the group that came together in Halifax on an ad hoc basis for Operation Oil headed by Dr. W.L. Ford, Director of the Atlantic Oceanographic Laboratory.*

We recommend that money for the support of relevant research at universities and in industry should be made available to the Ministry of Transport and disbursed on the recommendation of the headquarters team with the assistance of their scientific advisers.

The current division of responsibility and authority between the federal government and the provincial government if enforced would have led to anomalies and inefficiencies in Operation Oil and also, we understand, in the clean-up of the major spill at Deception Bay. At the present time, if oil is spilled into water from a ship pumping oil to a shore tank, it is a federal responsibility, whereas if oil is spilled into the same water with the oil flowing in the other direction, i.e., from the shore tank to the ship, it is a provincial government matter.

We suggest that the rational basis for a subdivision of responsibility and authority is the extent to which it is reasonable and efficient and economical to expect each level within society to have the capability, the scientific knowledge, and the resources to deal with the pollution effectively on a real-time basis and to maintain an adequate state of preparedness. Referring back to the definitions, *we recommend that*

1) *the federal government should have the operational responsibility and authority for all major spills at sea and should reach agreement urgently with the provincial governments concerning the responsibility for all other major spills.*

2) *with respect to moderate spills within provincial jurisdiction, agreements be reached with each province*

We can envisage some of the larger provinces wishing to be responsible for moderate spills while others would not have, and would have no justification for maintaining, a scientific and operational capability to cope. We see the responsibility and authority

for dealing with moderate spills as varying between federal and provincial governments on the basis of individual agreements. However, even in those cases where the provincial government had accepted the responsibility for the clean-up of moderate spills, the federal government should have some one one site from the MOT headquarters team ready and able to take over immediately should it beome apparent that the provincial government is unable to contain the situation.

3) *with regard to minor spills, agreements be reached between the provincial governments and municipalities, with the provincial government having someone on site to take over in case the municipality is unable to cope*

It would also be visualized that from time to time even a minor spill might require the province to call on the federal expertise because of the nature of the hazard involved or some other extenuating circumstance.

These interlocking agreements are essential and should present no difficulty, as is shown by our happy experience working in collaboration with the Government of the Province of Nova Scotia which responded immediately to any request for assistance from any member of their staff and was equally helpful in bringing to our attention local problems, complaints and difficulties as they arose.

In implementing the foregoing we can see the need for a number of working groups between various federal departments and between those concerned at the provincial, municipal and federal levels, but we would like to reiterate our recommendation that in our opinion effective operational action will only be possible if the responsibility and authority for this is placed in a small headquarters team reporting directly to the Deputy Minister of the Ministry of Transport.

Federal Preparedness

Federal preparedness should embrace two areas: one, the development and steady improvement of contingency plans to deal with spills on the East Coast, the West Coast, the Arctic, and the interior waters, with the concomitant contingency packets of material and equipment to ensure capability to react on a real-time basis; two, on ongoing research and development program in areas of special interest to Canada and a continuing review of the fruits of research and development in other countries.

The lead operational position with regard to these matters is detailed in the previous section and was recommended as being allocated to the Ministry of Transport. In this section we will identify certain critical facets in the roles of the various departments we have identified. We suggest that it be borne in mind that these recommendations are an outcome of our personal experience in Operation Oil and are not the result of an exhaustive study of the scientific competence, programs, goals and emphases of each of the departments. Our suggestions therefore should be considered in this light.

The Ministry of Transport

Apart from the scientific competence of the headquarters team itself, the Ministry should not set up any other scientific capability in the field of pollution containment, control and clean-up but it will be necessary for key people in the Coast Guard, in parts of the harbour administration, St. Lawrence Seaway, and at airports to develop and maintain the equipment in the contingency packets and the procedures in the contingency plans.

Department of National Defence

The Canadian Forces almost by definition must and will continue to have many of the skills and resources needed for effective action on pollution by oil or by other hazardous substances. We are convinced from our experience that these skills are in essence embedded in those which Canadian Forces require to discharge their primary responsibility. This is a good example of a role of national importance for National Defence. It would be difficult to find in a civil entity the kind of competence with quick reaction

capability inherent in the Navy diving team, or found in Canadian Forces operations officers with experience of integrated operations of land, sea and air and the overall communications capability. We wish to draw attention to a particular communications problem from our experience at Chedabucto Bay. There was no single frequency on which the Ministry of Transport, the Department of Fisheries and Forestry, the RCMP, and the Department of National Defence could communicate, We think this is a ridiculous situation and as part of their contribution, *we recommend that the Department of National Defence take on the responsibility of developing an operational communications plan so that in an emergency all segments of the federal government in the field can communicate with one another.*

The Department of National Defence can make a major contribution to the contingency packet. As will be seen from our chapter on costs, we had to spend close to $500,000 to have the salvage vessel *Curb* on site. Had *HMCS Cape Scott* not been engaged in a joint operation in Puerto Rico, she could have provided the essential features of the *Curb* with the exception of tug duties. It would have been simple enough to charter a good tug from a number of Canadian operators on the East Coast. We virtually had to take over a motel as our headquarters; we had to have *Narwhal*, and eventually *Cape Scott*, as a dormitory ship and we struggled with communications problems throughout the operation. All these requirements, which will be common to any other major spill clean-up, are embodied in *HMCS Cape Scott* and her sister ship on the West Coast, the *HMCS Cape Breton*. These ships can provide headquarters, communications, operations, repair and maintenance, accommodations and victualling and a most adequate factory capability together with mobility. Both ships have adequate storage capacity for all the essential items of a contingency packet. They have helicopter decks. In short, with the exception of a towing capability and the ability to receive recovered oil, they provide the complete range of facilities and flexibilities required for an operation such as Operation Oil.

We realize that for reasons internal to the Department of National Defence these ships are about to be laid up but we would urge that this situation be re-analysed. Because of the aperiodic nature of such actions, the ships could fulfil a variety of functions internal to the Department of National Defence, which in themselves may not have been sufficient to justify retaining the ships in an operating condition but would now become a dividend on top of the justified cost of preparedness. *We recommend that HMCS Cape Scott and Cape Breton be maintained operationally ready to fulfil primary roles in the national contingency plan.*

The Defence Research Board would continue to have a very specific and valuable contribution to make in the ongoing research and development of key areas in the fight against pollution.

Department of Energy, Mines and Resources

Energy, Mines and Resources would have a major responsibility in the ongoing research and development. There would need to be some work done in defining the boundaries of research done within that department, the Department of Fisheries and Forestry, and the Department of Indian Affairs and Northern Development and National Health and Welfare. At the working scientist level the co-operation is already excellent and if it can be quickly reflected by agreement at the executive level no problems need arise.

Department of Fisheries and Forestry

In addition to a strong and vital research and development role, where the only problem foreseen is that mentioned in the role of Energy, Mines and Resources immediately above, Fisheries and Forestry will have a regulatory and inspection role where fishing or fish products are likely to be affected by the pollution. Through this involvement they will have a responsibility for handling any claims for compensation or damage arising from the pollution and its effect on fisheries operations. The effectiveness

of the field officers was seriously reduced through a lack of clarity in the goals and emphases at their headquarters level. These were basically matters of principle which should be resolved without waiting for the next spill to occur.

Department of Indian Affairs and Northern Development

The role of Indian Affairs and Northern Development is of course largely concerned with spills in the north and therefore their potential contribution did not enter directly into our work at Chedabucto Bay with the exception of the Canadian Wildlife Service. The Canadian Wildlife Service provided a particularly valuable part of our scientific competence in the field.

We suggest it is urgent to clearly define the relative responsibilities of Energy, Mines and Resources, Fisheries and Forestry, and Indian Affairs and Northern Development so that their contribution under the overall responsibility of the Ministry of Transport can be maximized.

Department of National Health and Welfare.

The role of National Health and Welfare would be concerned with the health of individuals in the polluted area and in this there would need to be agreements with the provincial health authorities, but we presume these agreements, at least in principle, already exist. The relationship between Fisheries and Forestry on one hand and National Health and Welfare on the other could, we suggest, stand re-examination. We found that while Fisheries and Forestry had the responsibility for all other forms of fisheries harvest, for some inexplicable reason National Health and Welfare were responsible for clams, and yet the ordering of the closure and opening of clam beds is a responsibility of the Minister of Fisheries. Our inability to get meaningful responses from the scientists in National Health and Welfare on our clam problem we deduce is really a direct outcome of this rather odd division of responsibility and authority.

Department of Public Works

The Atlantic Regional Office of the Department of Public Works provided the engineering supervision for our dam building and beach cleaning operations with distinction. We see this as a natural ongoing responsibility for this department.

Provincial Preparedness

We see provincial preparedness falling into three main areas. The first is the co-operation and indeed integration of some of the key provincial personnel in the overall federal contingency planning. For example, the provincial Emergency Measures Organization provided indispensable members of the Operation Oil Team. Their detailed knowledge of the local resources, both in people and materiel, within the province and their ability to move outside the province through the EMO net to get similar advice from adjoining provinces were most valuable. Specialists from the Water Resources Commission, the Groundwater Division of the Department of Mines, and similar areas of specialized skill were closely involved in our operation. This is certain to be repeated in dealing with future major spills.

With regard to moderate spills, a contingency plan and a dovetailing with the federal contingency stockpile of such additional equipment and supplies as necessary would constitute a second area of preparedness. The third area would be the co-operation with the municipalities with regard to the handling of major spills.

We suggest that as a matter of right provincial governments should be able to pose problems in the research and development field to the federal team in the Ministry of Transport with the expectation that they would receive proper priority in the federal program of research and development.

Industrial Preparedness

We recommend that industry be heavily involved in research, development and production of equipment and material needed for the contingency packages on the one hand and the actual clean-up operations on the other, as well as devices to assist in the prevention of pollution incidents.

The oil industry, in particular, has three main areas requiring attention. The first is to bring about a radical improvement in the transportation of petroleum products, particularly that which is provided by ships under flags of convenience. From the pattern of spills of which we have direct knowledge or of which we have acquired knowledge through the literature, the majority result from avoidable negligence and stupidity. The best way of putting an end to these is by self-discipline within the industry. In our estimation there is little time remaining before punitive legislation will take this initiative out of the hands of industry.

We would like to make one point here, that while Mr. Justice Hart has found that the captain of the *Arrow* was responsible for the grounding and wreck of the ship, the captain was really just the final weak link in the chain that was entirely composed of weak links. If this accident had been subjected to the kind of detailed inquiry carried out in many countries with respect to civil aviation accidents, it would probably have been found that contributory negligence stretched all the way to the real ship owner through the labyrinth of corporate structures. Perhaps the navigation equipment on the *Arrow* was not in good condition because the owners were unwilling to spend the money or did their refit in ways that would be found wanting if subject to public scrutiny. We have listened to many stories, we have heard of many concrete examples, all tending to show, through each in itself not constituting hard evidence, that there is a degree of callousness and sloppiness in the industry that is not consistent with the public's concern with the environment circa 1970. We strongly urge industry to take cognizance of this and take action before others take action on their behalf.

The second main area of preparedness in which there can be a good industrial input is in the field of research. Imperial Oil, for example, has a competent research group in Sarnia. Several of them gave us valuable advice and assistance in the course of Operation Oil. We feel there is a special contribution that the oil industry's research capability can make to the prevention and control of pollution.

The third area of industrial preparedness we would suggest lies in special contributions to contingency plans and contingency equipment. The primary philosophy that must motivate the clean-up of oil spills or spills of hazardous material is to get the oil or material into safe storage, and if, as in our case, the substance is very largely contained in a wrecked tanker, the philosophy must be to get the oil out of the tanker and into safe storage without delay. The salvage of the vessel must be entirely secondary and only considered initially if it seems to be the best option in the recovery of the oil. We feel we must point out that had this philosophy been in existence at the time of the grounding of the *Arrow*, and had the legislation been such that the federal authority could have immediately taken charge of the situation and commandeered sufficient capacity of the coastal tanker tonnage in and around Nova Scotia, the bulk of the *Arrow's* cargo could probably have been recovered from the ship's tanks while the ship was still afloat. This is not recorded as a back-handed criticism of anyone. No member of the Task Force was present during those first seventeen days and we have no way of knowing how we would have reacted had we been there. But we do point out that in the light of the experience we now have, which must be translated into ongoing contingency plans, such a radical change in marine attitude, if brought about, could result in a major improvement in the containment of a pollution incident. As far as we can judge at the present time, the marine philosophy is almost the complete reverse of that which we recommended. At the present time the ships' owners and underwriters seem to have the philosophy of "save the ship, to hell with the cargo". If they re-examine this in the light of the real costs of cleaning up major spills they will see the fallacy of this philosophy.

We have had informal discussions with Imperial Oil regarding the new oil barge we understand they plan to build for coastal trade. With modest additional capital expenditure at the time of its construction, this barge could become the primary receiving vehicle for any incipient tanker spill on the East Coast. If this additional capital expenditure were shared among the industry, it would be a minor charge to each company. If in return Imperial Oil were willing to designate it as the primary recovery vehicle and subject to immediate call, then even if she was called while full of petroleum products, other coastal tankers could come alongside and receive the barge's oil faster than the barge could recover oil from a wrecked tanker. Therefore the barge could be about its normal trade and still provide an acceptable and vital part of the contingency packet. We would suggest that the industry examine their capability of producing a similar tankerage capability on the West Coast. The Arctic and inland waters will entail other problems which will need special consideration.

We recommend that the oil industry reach agreement among themselves to provide on immediate call from a Federal Government Task Force suitable oil recovery vessels.

A Contingency Plan

While the title of this section is in the singular, we foresee the need for a variety of contingency plans for which the headquarters team in the Ministry of Transport will have primary responsibility for iniating and up-dating. We consider, however, that there will be a common philosophy running through these plans which on the one hand will reflect the latest advances in science, engineering and technology and which in turn will pose the new critical problems for priority research, and on the other hand will reflect the experience we have had until other experience replaces it.

The choice of the best methods of recovering oil from the water and the shores is severely limited by the vast amount of ignorance in the physics and chemistry of petroleum products in a cold environment. The biological effects of petroleum products in emulsions with water and with a variety of additives are virtually unknown, and further limit the choices.

During the course of Operation Oil we received a tremendous number of suggestions covering all phases of our operation. These were examined in the light of the partial knowledge we had of the circumstances that we were facing and decisions made. These are reflected in the equipment and methods used and in the contingency plan items we recommend on the basis of our experience. Each one of these decisions should be challenged by the headquarters team and they should review the entire galaxy of ideas which we received and which we will be turning over to the Ministry of Transport as part of the archival material resulting from Operation Oil.

The central theme of the contingency plan we recommend is that every effort must be made to contain the oil, to recover it into safe containers, and to prevent it spreading over the water surface and onto the shores. The salvage of the vessel, whatever it may be, is a purely secondary consideration. Secondly, until or unless research establishes to the satisfaction of the scientific community that the massive use of dispersants or sinking agents does not cause unacceptable ecological damage, neither technique should be used. We realize that some oil companies are engaged in a major advertising campaign recommending that oil slicks should either be loaded with treated sand or chalk so that they sink to the bottom, or dumped into the water column with the use of dispersants. With regard to the former practice, we characterize this as merely sweeping the dirt off our own door step onto the doorstep of the lobster. We feel the world is rapidly finding out that man has been playing this kind of trick too much for too long. The latter practice, i.e., the massive use of dispersants, we characterize as sweeping the dust under the rug. It is a sloppy habit when it is practised in man's own home and at the present state of our knowledge it is unacceptable when the "under the rug" area is the habitat of a major number of links in the food chain of this world. These practices may be born of the old adage that "out of sight is out of mind", and thereby the public pressure on the company to clean up its own mess evaporates. We suggest that this is a callous and

unacceptable attitude and that the contingency plan and operations in any spill of petroleum products must reflect a concern for the total environment.

A contingency plan must have three main components:

1. There should be a plan for the recovery of such oil as remains in the primary vehicle from which the oil was spilled. Here we can see a major role for National Defence because the skills and capabilities required are almost identical with those developed within the Canadian Forces' training for their primary mission. We see important supporting roles for the Canadian Coast Guard and the Meteorological Service. It is important that the contribution of each be brought to the same stage of mobility and flexibility as is indigenous to the Canadian Forces. For example, the Meteorological Service must be capable of immediately mounting a field operation as was done at Port Hawkesbury. The safety and efficiency of many of the operations will depend on a good meteorological service in situ. An integrated communications capability, with all units capable of operating on a common frequency, is likewise indispensable and will require careful planning and exercising. This part of the plan should also involve to a major extent the oil companies because it is important that they have immediately available a recovery vehicle. *We recommend that, until a better scheme is developed, the tankers and barges used in the petroleum trade be fitted with the Madsen valves.* In the Arctic the provision of a receiving vehicle equipped for a rapid pump-out in case of accident, while representing a substantial expense because it would have to be provided on a stand-by basis, may yet be a very cheap form of insurance.

   The two essential vehicles for the East and West Coasts should be able to earn their keep in other ways while performing a stand-by service. We refer firstly to *HMCS Cape Scott* and *Cape Breton* which would provide the headquarters' operational and factory capability, and secondly to the receiving vehicle for recovered oil which we have recommended be provided by the industry and be engaged in the normal coastal trade.

2. The second main part of the plan would be preparedness for recovering oil from the water. This will require the immediate availability of equipment and materials for containment and recovery.

   Until other vehicles are proven to be more satisfactory *we recommend that at least one slick-licker be placed at each major port on the Canadian coast and that at least two others be held in a central contingency packet.*

   Until further engineering and development is done, we suggest that these slick-lickers be mounted on the equivalent of the 27-foot SP barge used at Chedabucto Bay but that as a matter of urgency a more satisfactory vehicle, probably of a catamaran basic design, should be developed. The catamaran developed for Operation Oil was a useful vehicle but we would not recommend its basic design as acceptable on an ongoing basis. The tongue of the slick-licker must project beyond the bows of the craft and the propulsion of the craft must be able to operate in highly contaminated waters.

   We recommend that stockpiles of material be located at strategic ports. These would include peat moss or other absorbents, booms and boom components, and a variety of equipment not readily available which will vary with each location.

   We recommend that the Canadian Coast Guard have primary responsibility for the recovery of oil floating on the water, which will include slick-lickers, containment booming, and all other ramifications.

   Our basic philosophy is that just as each major port is equipped to fight fires, so it should also be equipped to fight oil pollution on the same real-time basis.

3. The third main phase of the plan is the cleaning of the beaches and the shoreline. There is much research work required here but the plan should include the use of basic equipment of tracked bulldozers, front-end loaders and trucks which can with

limitations do a good job. Lightly contaminated or sensitive beach should be cleaned by manual labour. Road graders found satisfactory in other clean-ups were tried but were not useful because our beaches were either too soft or had too much slope. We believe the graders might be satisfactory on a flat hard sand beach. We developed no acceptable way of cleaning boulder beaches. It is urgent that the contingency plan develop some approach to this problem. The only encouraging result we had was in the use of finely powdered natural material as stabilizers. Finely powdered limestone did offer some hope of success as a stabilizer of oil on boulder beaches and bedrock, but much work remains to be done in this area.

In this part of the plan we would also include the cleaning of wharves, jetties and retaining walls. After examining a number of proprietary methods used in the trade for tank cleaning, etc., we decided to use old-fashioned steam jennies and steam guns. This approach worked and we suggest should be part of the contingency plan unless some other method shows substantial improvement and cost effectiveness.

We recommend that the Canadian Coast Guard be responsible for the steam cleaning operations. We also recommend that the Department of Public Works provide engineers to supervise the beach cleaning operation.

Community Relations

As is brought out in other sections of this report, community relations is a vital part of an operation such as Operation Oil. We prefer the title "community relations" rather than information services or public relations because we suggest that a multi-directional problem-oriented communications organization is necessary. It is absolutely vital that the community be kept fully informed, not only of the hazards of the pollution incident, but of the economic and social consequences as foreseen by the team. Conversely the team must be kept fully informed of the problems arising from the pollution incident as seen by the communities in the affected area. Complaints of all sorts should be encouraged and should be checked out whether they seem real or unreal because underneath each will be some economic or social problem which the individual feels incapable of handling alone. Some of these problems may have existed prior to the pollution incident but may have been exacerbated by the event.

Two-way communication must be maintained between the team and the elected representatives of the people at the municipal, regional, provincial and federal levels because in the face of a major pollution incident people naturally will turn to their elected representatives for action. It is important from the standpoint of the effectiveness of the team that the complaints and suggestions reaching the elected representatives of the communities be fed into the team's organization without delay. Conversely, those who represent the communities should be informed of the team's actions so that if any of them seem ill-considered or untoward, changes can be made simply and directly. It is also important that the news media be kept fully in the picture. An increasing portion of the public will not come to meetings even when the issues are serious but rely on the news media as the primary source of information. In general the news media have a very unhappy reputation for distortion and magnification beyond the level of acceptability when reporting on human disasters. It is vital that the news media serving the affected area strive for 100 per cent factual reporting. This challenge was given the local news media in Cape Breton and it is our pleasure to report that their record is one of substantially 100 per cent accuracy. They provided a major service to the scattered communities throughout the area in bringing accurate and timely and understandable advice before the people. When the news travelled as far as Halifax, degradation was already noticeable, and by the time the news travelled as far as Montreal, Ottawa and Toronto, major distortion had set in. By the time the news got into the United States it was in some instances almost unrecognizable. We had samples of material for the national television news being taken on site and then delayed days or even weeks before it was run as real-time news. During the interval the situation has changed completely so that concerns and apprehensions were raised without valid foundation.

We recommended that very careful attention be given to the community relations aspects of contingency and operation plans and that those information officers who are capable of effectively operating in a community relations setting be identified, involved with the headquarters team in the planning, and be immediately available when operations are mounted to deal with a pollution incident.

Scientific Preparedness

One of the major responsibilities of the headquarters team will be to ensure an ongoing intelligent assessment of the world's storehouse of knowledge relevant to the problems of pollution from oil or other hazardous substances and to effectively change, through co-operation and contract, that segment of the scientific community that has the expertise to assist.

A central library of literature in this field will be indispensable. *We recommend that the National Science Library be the central repository for literature dealing with oil pollution and that there should be no proliferation of library holdings in the various federal governmental departments.* They can and should be able to meet their own requirements by accessing the collection at the National Science Library.

As the contingency plans are developed, certain gaps in our knowledge will become evident. These should be critically and urgently examined to determine whether sufficient research is being done in other countries or whether the need is sufficiently specific to the Canadian contingency plan that it should be undertaken in Canada. The team will also have to be on the alert to identify good ideas or unsolicited proposals of worth that should be funded as part of the overall scientific preparedness.

Certain industrial laboratories should be identified for thier competence in this area and encouraged to participate, in particular the research laboratories of the oil industry itself. We see also an opportunity for Canadian development and innovation in the appurtenances of clean-up technology. Industry should not only be able to develop the tools that are needed for preparedness in Canada but with a growing world-wide recognition of the problem, offshore sales should be possible if the industry is alert and sufficiently aggressive to compete with the very substantial effort in this field evident in the private sector in other countries.

The following is a list of urgent research and development projects which we were able to identify as a result of our experience in Operation Oil. In presenting these, we wish to emphasize that this is not presented as a shopping list for Canadian research initiative, but rather as a range of problems that need to be attacked. We would like to stress the importance of international co-operation in the solution of these problems. In addition to supporting the "bright ideas" that emerge from the Canadian scientific community, our efforts should largely be directed toward the specific problems of a cold environment where we have both a special competence and a special interest.

(1) The physics of petroleum products in a cold environment.

(2) The chemistry of petroleum products in a cold environment.

(3) Microbial degradation of petroleum products in the water and on land, with particular reference to a cold environment.

(4) The life history of oil in the water column.

(5) The toxicity of petroleum products and mixtures of petroleum products, and mixtures of petroleum products with water and dispersants.

(6) Long-term effects of petroleum products or mixtures of petroleum products with water and dispersants on marine fauna and flora.

(7) The fingerprinting of oil and water-in-oil emulsions.

(8) The natural weathering of petroleum products in a cold environment.

(9) Debunkering and other means of dealing with oil in a cold environment.

(10) Oil containment booms, with particular reference to booms for exposed locations and booms for use in ice-infested waters.

(11) High-volume filters to remove petroleum products from water.

(12) Absorbents.

(13) Burning techniques for petroleum products spills on water.

(14) Sinking agents and ecological consequences of sinking oil slicks.

(15) Dispersants and the ecological consequences of using dispersants.

(16) Mechanical ways of removing oil from the water surface.

(17) Beach cleaning technology, including stabilization of the oil *in situ.*

(18) Combustion of recovered material where reclamation of the oil is not practical: (a) oil in emulsion and mixed with combustible materials; (b) oil in emulsion and mixed with gravel, sand or other non-combustible materials.

(19) Oceanographic factors, e.g. prediction of the movement of oil slicks on the water surface.

(20) Aerial detection, surveillance and tracking of oil slicks.

(21) The overall ecological consequences of oil spills and spills of other hazardous substances in water.

(22) The economic consequences of oil spills or spills of other hazardous substances.

(23) The social consequences of major spills of petroleum or other substances.

We recommend that the initial funds to support the Canadian research effort on oil pollution problems in universities and industrial laboratories be $250,000 per annum.

The subsequent years' costs will rise but we feel that the headquarters team with its advisers should be looked to to make recommendations for subsequent years, as the rate of increased funding will depend to a considerable extent on the subjects chosen for research in Canada and the number of competent scientists and engineers involved.

PART 7 - ACKNOWLEDGEMENTS

While in an operation such as this it is impossible to give due credit to all of those who participated in many ways and who contributed to the solution of the many problems, we wish to record here to all of them our sincere appreciation for their efforts and co-operation.

At the risk of being unjust through omission we feel we must make some specific acknowledgments.

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To the Fisheries Officers in Chedabucto Bay.

We would like to use this report to thank all those, from all parts of Canada and other parts of the world, who took the time to write their ideas, their suggestions and their thoughts to us. They were all helpful, they were all considered, and the fact that we did not in the final analysis choose to follow many of their suggestions is more a measure of our judgment in the light of the circumstances we were facing than it is a measure of the quality of their suggestions. So we can but hope that if disaster should strike again on some other part of the Canadian coast, Canadians would respond with equal generosity with their ideas.